INSTITUTE FOR QUANTITATIVE RESEARCH IN FINANCE®

SUMMARY

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I. INTRODUCTION, SUMMARY AND CONCLUSIONS

John O'Brien delivered the opening address at the Spring 2005 Seminar of The Q-Group®, discussing the history of Financial Engineering, from the 1960s, when rocket engineers became financial engineers.

Geert Rouwenhorst described his research on commodity futures, focussing on an index and its performance. He explained the concepts of contango and backwardation and the expected relationships of commodity spot price, futures price, and expected future spot price. Campbell Harvey followed, with a different approach to commodity futures, and a special emphasis on active management strategies. Harvey presented evidence on inflation effects and significant differences between commodity price and futures price behavior. Pierre Collin-Dufresne added a more elaborate modeling approach, with particular attention to the role of convenience yield in commodity futures rates of return.

David L. Greene described the modeling of the future of oil production and consumption and the implied time of production peaking. He pointed out critical features of forecasts and the special importance of OPEC's influence.

Richard Michaud introduced the Financial Engineering topic, with a review of accomplishments to date, up to the introduction of ETFs. Charles (Tony) Baker described technology developed and tested by the American Stock Exchange for the trading of actively managed mutual funds as ETFs. He presented the Exchange methodology as ready to perform when regulatory approval is obtained. George Sauter continued, with details of the process that had been set out by Baker. Gary Gastineau offered a new model for mutual funds, similar in some respects to ETFs but offering further advantages. He offered significant reductions in the costs to investors of using mutual funds and improved incentives to managers.

Thomas Ho presented a model for the design of a hedging process for insurers that provide a variety of guarantees to purchasers of variable annuities. He demonstrated the identification of the appropriate hedging instruments.

Nicholas Barberis reported research on comovement that it unrelated to fundamentals, but is based more on investor sentiment and such factors as the market in which assets are traded. Empirical testing confirmed the importance of the suggested forms of comovement.

Robert Fernholtz discussed stock market diversity, its nature and importance to portfolio rate of return, and offered some techniques for increasing diversity and hence returns. It is important that the return improvement does not result in increased risk.

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1. Financial Engineering: Beyond Slicing and Dicing

The opening presentation of the Spring 2005 Q-Group® Seminar was given by John O'Brien, Executive Director, Masters Program in Financial Engineering, Haas School of Business, U.C. at Berkeley. O'Brien had been associated with the Q-Group® as a speaker at some of the very early meetings, along with some of the co-founders of O'Brien Associates. He spoke at the Fall 1980 and at the Fall 1985 seminars. His topic this time was the origin and development of Financial Engineering, and he offered some suggestions with respect to its future.

He traced the origins of financial engineering back to a series of chance happenings that brought together a number of people trained in quantitative techniques, recently released from employment and eager to put their skills to work. The time was the early 1960s, just the time for "rocket engineers" to put their minds to something that would become financial engineering. O'Brien's first assignment was to find out why a profit sharing fund appeared to be performing badly. Out of that assignment came the development of risk adjusted performance measurement. Quantitative finance began to catch on. The Q-Group® was established in the 1960s. The New York Society formed its Computer Applications Committee. Two competing purveyors of beta books appeared and the competition by itself seemed to create a market for beta coefficients.

The 1970s and 1980s saw far more progress. O'Brien reeled off the names of a host of academics and practitioners who have become famous for successful innovations. He himself developed simulations to demonstrate the results of investment strategies. Index funds were born. The Black-Scholes Option Pricing Model appeared. Portfolio insurance, a brilliant idea that proved less than completely successful, emerged. Good ideas did not always work.

Turning to the future, he proposed that the principles of financial engineering might be applied to a number of larger problems facing society. Life-cycle investment planning is one of them. Bodie, Schiller and Merton have written books on this subject and their ideas are worth studying. The time is right for new financial instruments, particularly in the form of life-cycle insurance.

Commodities As An Asset Class

2. The Long Term Performance of Commodity Futures

K. Geert Rouwenhorst, Professor of Finance, Deputy Director International Center for Finance, Yale University, made available a paper by himself and Gary Gorton of the Wharton School, University of Pennsylvania and the National Bureau of Economic Research, entitled "Facts and Fantasies About Commodity Futures."

The paper began with a brief introduction to commodity futures and some explanations of terminology and basic concepts. A commodity futures contract is an agreement to buy (or sell) a specified quantity of a commodity at a future date, at a price agreed upon when the contract is entered into — the futures price. At that point, no cash changes hands, and the value of the contract is zero at its inception. The

contract is essentially a bet on the future spot price. The rate of return an investor can expect to earn is the risk premium: the difference between the current futures price and the expected future spot price. As the current futures price moves towards the expected future spot price, the contract is marked to market daily, and daily cash settlement follows.

Keynes' (1930) and Hicks' (1939) theory of *normal backwardation* postulated that the risk premium would on average accrue to the buyers of futures. They envisioned a world in which producers of commodities would seek to hedge the price risk of their output and would hence sell futures to lock in a future selling price. Speculators would purchase the futures, in effect providing insurance to the sellers. The speculators would demand a futures price below the expected spot price, anticipating a risk premium for assuming the risk of price fluctuations. The assumption here was that those seeking to hedge price risk were sellers and hence the risk premium would be earned by those who purchased futures contracts. However, we know now that buyers may also wish to hedge price risk by buying futures contracts, in which case the investor or speculator providing insurance will be a seller of the contract, and will participate only if the price of the futures contract is greater than the expected spot price of the commodity.

To investigate the long-term return to commodity futures, the authors constructed an equally-weighted performance index of commodity futures. Rouwenhorst discussed the advantages of working with an index and described the data collection that had been necessary to construct their index. This was a substantial undertaking, and he considered it a significant part of their work.

He turned next to empirical evidence on spot and futures returns. Futures positions were considered to be collateralized, generally by a 100% investment in Treasury Bills. He compared the performance of the collateralized futures position with the spot return for the "average commodity future." A first conclusion was that the historical returns to an investment in commodity futures have far exceeded the return to a holder of spot commodities. He showed that the average returns of a futures index rebalanced monthly to equal weights and of an index that does not rebalance are very similar, and somewhat lower than returns on an index that rebalances annually. The frequency of re-balancing has a larger influence on the spot index returns and lowers those returns. The geometric average buy-and-hold spot return of 3.47% per annum from 1959-2004 was lower than the average inflation of 4.15%, consistent with the common wisdom that over the long-term commodity prices have not kept pace with inflation.

Over the period 1959-2004, the average historical risk premium of commodity futures has been about 5% per year, about equal to the risk premium of stocks, and more than double the risk premium of bonds.

Turning to risk measures, he showed that the historical volatility of the equally-weighted commodity futures total return has been below the volatility of the S&P 500. Further, commodity futures returns are positively skewed while stock returns are skewed negatively. In addition, commodity futures display relatively high kurtosis and can be especially helpful in months when stocks perform particularly badly.

He next focused on unexpected

inflation. The negative sensitivities of stocks and bonds to inflation stem mainly from sensitivities to unexpected inflation. Commodity futures are also more sensitive to unexpected inflation, but in the opposite direction. Once again, commodity futures offer strong diversification benefits.

It turns out that commodity futures have some power at diversifying the systematic component of risk, the part that is not supposed to be diversifiable. Futures perform well in the early stages of a recession, a time when stock returns generally do poorly. In later stages of recessions, commodity returns fall off, but this is generally a good time for equities.

The empirical evidence discussed so far is consistent with Keynes' theory of normal backwardation. The current practice is to use the term contango to refer to cases where the futures price exceeds the current spot price, while futures priced below the current spot price are referred to a being in backwardation.

Finally, Rouwenhorst discussed the difference between investing in commodity futures and investing in the stocks of commodity producing companies. It turns out that commodity company stocks behave more like other stocks than like their counterparts in the commodity futures market. An investment in commodity company stocks has not been a close substitute for an investment in commodity futures.

3. The Tactical and Strategic Value of Commodity Futures

Campbell R. Harvey, J. Paul Sticht Professor of International Business, Fuqua School of Business, Duke University had made available a paper by himself and Claude B. Erb, Managing Director, Trust Company of the West entitled "The tactical and Strategic Value of Commodity Futures."

The previous presentation on commodity futures by Geert Rouwenhorst had focused on analysis of an index of commodity futures. Harvey's focus, on the other hand, was primarily on individual commodity futures or on particular sectors. Some of Harvey's conclusions, particularly with respect to inflation hedging, differed from those of Rouwenhorst and much of this was a function of the different focus. In addition, Harvey was particularly interested in opportunities for tactical strategies in the futures market.

He reviewed the three most commonly used commodities futures indices, the Goldman Sachs Commodity Index (GSCI), the Dow Jones-AIG Commodity Index (DJ AIG), and the Reuters-CRB Futures Price Index (CRB). Since the GSCI open interest represents 86% of the combined open interest of the three indices, Harvey based most of his analysis on data from it. The GSCI currently invests in 24 underlying futures contracts and is heavily skewed towards energy exposure because its portfolio-weighting scheme is based on the level of worldwide production for each commodity. It turns out that there are rather low correlations among the three indices, because of their different weightings.

In the overview to his presentation he made five points:

- The term structure of commodity prices has been the driver of past returns
  - And it will most likely be the driver of future returns

- Many previous studies suffer from serious shortcomings
  - Much of the analysis in the past has confused the "diversification return" (active rebalancing) with a risk premium

- Keynes' theory of "normal backwardation" is rejected in the data
  - Hence, it is difficult to justify a 'long-only' commodity futures exposure

- Commodity futures provide a dubious inflation hedge

- Commodity futures are tactical strategies that can be overlaid on portfolios
  - The most successful portfolios use information about the term structure

In exploring the sources of return in commodity futures he began with the diversification return. This is essentially the return due to rebalancing of weights in a group of futures. Quoting from Booth and Fama, 1992, he noted:

> "*For a portfolio with a constant percentage invested in each asset,* the compound return is the sum of the contributions of the individual assets in the portfolio. The portfolio compound return is greater than the weighted average of the compound returns on the assets in the portfolio. *The incremental return is due to diversification*. The contributions of each asset exceeds its compound return by the amount it adds to the portfolio diversification return.
>
> The compound return on an asset is approximately the asset's average return minus one half the asset's variance. A portfolio's average return is the weighted average of each asset's average return, but a portfolio's variance is the weighted average of each asset's covariance."

Harvey's position is that the payoff to rebalancing is not a risk premium, it is an active strategy return. He followed with some examples and the mathematics of the diversification return.

He continued with the components of commodity futures excess returns. The two components are roll return and spot return. The roll return comes from maintaining a commodity futures position, selling an expiring futures contract and buying a yet to expire contract. This is somewhat analogous to rolling down the bond yield curve. The spot return comes from the change in the price of the nearby futures contract. The key driver of the roll return is the term structure of futures prices and the key driver of the spot return might be something like inflation. He demonstrated both drivers of futures returns graphically. Two distinct term structures go with the backwardation and the contango configurations. Backwardation refers to futures prices that decline with time to maturity (crude oil futures are an example), while contango refers to futures prices that rise with time to maturity (gold is an example).

He turned next to normal backwardation. The theory says:

- Commodity futures provide "hedgers" with price insurance, risk transfer

- "Hedgers" are net long commodities and net short futures

- Futures trade as a discount to expected future spot prices

- A long futures position should have a positive expected excess return

This theory, of course, applies to the case where the hedger is net long commodities and net short futures, but we find that some hedgers are short commodities and long futures and in this case a short futures position should have a positive expected excess return.

Next Harvey considered commodity futures as an inflation hedge, correlated with unexpected inflation. Historically, the GSCI has been highly correlated with unexpected inflation. But he raised the question do all commodity futures have the same unexpected inflation sensitivity? It turns out that commodity futures with the highest roll returns have the highest unexpected inflation betas. It also turns out that the average commodity itself trails inflation.

Finally, he turned to four tactical approaches. First, when the price of the nearby GSCI futures contract is greater than the price of the next nearby futures contract (when the GSCI is backwardated) we expect that long-only excess returns should on average be positive. Second, making use of momentum, go long the GSCI for one month if the previous one year excess return has been positive or go short if the previous one year excess return has been negative. Third, for individual commodities go long the six most backwardated constituents and go short the six least backwardated constituents. Fourth, form individual commodity momentum portfolios, by investing in an equally-weighted portfolio of the four commodity futures with the highest prior twelve-month returns, a portfolio of the worst performing commodity futures, and a long/short position.

4. Modeling the Dynamics of the Term Structure of Commodity Futures

Pierre Collin-Dufresne, Associate Professor of Finance, Haas School of Business, U.C. at Berkeley had made available two papers, the first being "Equilibrium Commodity Prices with Irreversible Investment and Non-Linear Technologies," by himself, Jaime Casassus, Pontificia Universidad Catolica de Chile and Carnegie Mellon University, and Bryan R. Routledge, Carnegie Mellon University. The second is "Stochastic Convenience Yield Implied From Commodity Futures and Interest Rates" by himself and Jaime Casassus.

The paper presents an equilibrium model of commodity spot and futures prices for a commodity whose primary use is as an input to production, such as oil, and captures many stylized facts of the data, which the authors review.

Empirical studies of time series of commodity prices have found evidence of mean-reversion and heteroscedasticity. Further, combining time series and cross-sectional data on futures prices provides evidence of time-variation in risk-premia as well as existence of a 'convenience yield' (Fama and French (1987), Bessembinder et al. (1995), Casassus and Collin-Dufresne (CC 2002)). Interestingly, the empirical evidence also suggests that there are marked differences across different types of commodities (e.g., Fama and French (1987). It appears that 'convenience yields' are much larger and more volatile for commodities that serve as an input to production, such as copper and oil, as opposed to commodities that may also serve as a store of value, such as gold and silver. Gold and silver markets exhibit mostly upward sloping futures curves with little variation in slope, whereas copper and especially oil futures curves exhibit more volatility. In particular, oil future curves are mostly downward-sloping

(i.e., backwardation), which, given the non-negligible storage costs indicates the presence of a sizable 'convenience yield.'

Collin-Dufresne was particularly interested in the significance of the convenience yield and its role in the valuation of futures contracts. The convenience yield is defined as an implicit dividend that accrues to the holder of the commodity (but not to the holder of the futures contract). This definition builds loosely on the insights of the original 'theory of storage' (Kaldor (1939), Working (1948, 1949), Telser (1958), Brennan (1958)) which argues that there are benefits for producers associated with holding inventories due to the flexibility in meeting unexpected demand and supply shocks without having to modify the production schedule.

The authors' model has regime switching between the *near-investment* and the *far-from-investment* regions. There is an infrequent state that is characterized by high prices and negative return and a more frequent one that has lower average prices and exhibits mean-reversion. To further test the model the authors estimate the smoothed inference about the state of the economy (Kim (1993)), i.e., they back out the inferred probability of being in one state or the other. They find that, as predicted by the theoretical model, futures curves are mostly convex in the near-to-investment region but concave in the far-from-investment region, reflecting the high degree of mean-reversion when investment and a drop in prices is imminent.

Crude oil futures prices were obtained from the New York Mercantile Exchange (NYMEX). They used daily prices from 1/2/97 - 8/29/03 and contracts with maturities of 1, 6, 12, 18, 24, 36, 48, 60, and 72 months. They consider this period of time in order to include contracts with longer maturities. The contracts with the higher number of observations are the 1-, 6-, and 12-months maturity contracts with 1653 observations, while the one with the lowest number of observations is the 72-months contract with 1457 observations. For the period considered, the means and volatilities of futures prices decrease with the maturity of the contract. This implies a high degree of backwardation in crude oil prices (in their dataset 66% of the time the 6-months maturity contract is below the 1-month maturity contract).

He described the conclusions as follows:

We develop an equilibrium model for spot and futures oil prices. Our model considers the commodity as an input for a production technology in an explicit way. This feature endogenizes one of the main assumptions in standard competitive models of storage, i.e. the demand function. Our model generates positive convenience yields and long periods of backwardation in futures curves without the necessity of running out of oil, like the standard "stock-out" literature. Convenience yields arise endogenously due to the productive value of the oil, which is consistent with the predictions of the "Theory of Storage". This convenience yield is high when the stocks of commodity are low, and vice versa. By modeling explicitly risk-averse agents, we can investigate risk-premia associated with holding stocks of commodities versus futures contracts.

Equilibrium spot price behavior is endogenously determined as the shadow value of oil. Our model makes predictions about the dynamics of oil spot prices and futures curves. The equilibrium price follows an heteroscedastic mean-reverting process.

The spot price is non-Markov, because there are two regimes in our economy that depend on the distance to the investment region. For reasonable parameters, the futures curves are most of the time backwardated. Also, the two regimes imply that two futures curves with similar spot prices can have very different degrees of backwardation.

We calibrate the model using futures price and economic aggregates data. We find that the model captures many of the stylized facts of our data set. In particular, our model can reproduce the means and volatilities of futures prices for maturities up to 72 months and also the average consumption of oil-output and output-consumption of capital ratios. We estimate a linear approximation version of our model with crude oil prices from 1982 to 2003. Our empirical specification successfully captures spot and futures data. Finally, the specific empirical implementation we use is designed to easily facilitate commodity derivative pricing that is common in two-factor reduced form pricing models.

5. Running Out Of and Into Oil: Analyzing Global Oil Depletion Through 2050

David L. Greene, Oak Ridge National Laboratory made available a paper entitled "Running Out Of and Into Oil: Analyzing Global Oil Depletion and Transition Through 2050", prepared for the US Department of Energy, October 2003, by himself and Janet L. Hopson and Jai Li of the University of Tennessee.

He began by tracing some of the recent history of oil production end use and the special importance of OPEC. He noted that the modern debate over oil production and consumption has made a useful shift from concern over "running out" to the "peaking" of oil production, the date beyond which oil production can no longer be increased. With reference to OPEC, he noted that the US Energy Information Administration appears to be counting on significant increases in production from OPEC although it seems clear that OPEC can profit more by holding back production in anticipation of rising prices.

For the most part, geologists are pessimistic about oil production and expect it to peak by 2010. Economists, on the other hand are generally optimistic. They count on technological progress to exceed the rate of depletion and believe that the market system will provide sufficient incentives to expand and redefine resources. Greene takes the optimistic view, but seeks to quantify it.

It is important to distinguish at least two kinds of oil. Conventional oil is in the form of liquid hydrocarbons of light and medium gravity and viscosity, in porous and permeable reservoirs, plus enhanced recovery and natural gas liquids. Unconventional oil consists of deposits of a density greater than that of water (heavy oil), of viscosity greater than 10,000 cP (oil sands) and of tight formations (shale oil). Although some production has begun on unconventional oil sources, the expectation is that conventional oil, being cheaper to produce, will take care of demand until a shortage leads to reliance on unconventional.

There is considerable uncertainty about how much oil there is. The year 2000 study of the US Geological Service indicates about 3 trillion barrels of conventional oil, plus another 300 billion if natural gas liquids are included. These estimates include cumulative production to the year 2000 of 540 billion barrels.

In his study, Greene relied on three sets of estimates: USGS 2000 conventional oil estimates plus the unconventional oil estimates synthesized from USGS/WEC/IEA; Rogner's 1997 estimates; and estimates based on Campbell's (2003) year-end 2002 global assessment. Campbell's estimates are at the pessimistic end of the scale while those of the USGS are optimistic.

For modeling purposes, six depletion/transition scenarios were constructed. They were based for the most part on existing projections of production and energy use. It is convenient to distinguish Middle East oil production from non-Middle East (NME) oil production. The latter is carried on essentially under competitive conditions, while the former is at least at present under monopoly conditions.

The six scenarios test three alternative sets of conventional and unconventional oil resource estimates against a reference world energy scenario, then test somewhat higher and radically lower energy scenarios against the resource estimates based on the USGS assessment and finally examine the implications of a pessimistic assessment of world oil resources in the low energy use scenario.

Changing Middle East production forces demand and supply from other regions to adjust, but they will adjust from the scenario values to which they have been calibrated. As a result, changing Middle East production does not produce a new long-run equilibrium energy supply and demand scenario consistent with the new Middle East path. Rather it produces an adjustment of demand in NME supply to an unexpected change in Middle East supply.

The risk analysis simulations based on the USGS assessment indicated an expected peak year for conventional oil production from NME of about 2023, with a roughly 10% probability that the date would be later than 2028. The results suggest only a 5% probability that the peak year will occur before 2016 and essentially no chance of non-Middle East conventional oil production peaking before 2010. In sharp contrast, simulations based on Campbell's data indicate little chance of the peaking date occurring after 2010 and an expected peak production date of 2006.

Simulations using USGS resource estimates indicate that the peak year for world conventional oil production will be sometime after 2015 but is more likely to occur after 2040 than before. Rogner's estimates produce greater certainty of a conventional oil peak occurring before 2050. And Campbell's estimates point to 2015 as the expected date of peak world conventional oil production.

Greene went on to discuss the sensitivities of peaking dates to key parameters. The most important factor overall is the rate of increase in production from the Middle East and Northern Africa. The target reserve/production ratio for NME producers is the second most important factor. The higher the target ratio, the sooner NME production peaks but the flatter the peak is. Since the world peak is largely determined by Middle East output, a long flat NME production curve postpones the overall world peak. The world peaking date depends strongly on only one factor: the rate of increase in Middle East production. Greene concluded that using the estimates based on Rogner or the USGS, peaking of NME conventional oil production is likely sometime between 2010 and 2030. Under a wide range of

assumptions the rate of growth in world conventional oil production will slow substantially after 2020 if it does not decline. The transition to unconventional oil will be rapid if the growth of oil consumption continues at current rates or rates projected through 2020 by the Energy Information Administration. At first, unconventional oil supplies are likely to come from the oil sands resources of Canada, followed by increased development of Venezuelan and Russian resources. If growth and demand continue, US shale oil (or some other source of liquid hydrocarbons) will begin to be developed at a rapid pace following the peaking of conventional oil production from NME regions.

It appears that OPEC market dominance is robust to a wide range of alternative demand and resource availability scenarios. This is evidenced by OPEC's ability to maintain market share in the vicinity of 30 percent to 50 percent over the entire 50-year period in all scenarios and variants. Moreover, the Middle East will remain the lowest cost supplier of oil. While the emergence of large-scale unconventional oil production could put a cap on long-run oil prices, with the majority of the world's proved conventional reserves, Middle East producers will have the ability to temporarily raise or lower world oil prices throughout the period.

II. New Developments in Financial Engineering

Richard Michaud offered an introduction to the financial engineering part of the program. Index Exchange-Traded Funds (ETFs) build on four historical financial engineering innovations: mutual funds, index funds, program trading and Superdot technology.

Mutual funds were a major innovation in asset management. They offer professional management and diversified portfolios. The pioneer was Massachusetts Investment Trust (MIT) in the 1920s, with only one class of investors, a published portfolio and redemption on demand. The innovation was very successful and U.S. equity mutual funds are a three trillion dollar industry. Mutual funds were and are the cornerstone of Boston's financial economy and world importance.

Index funds were another important financial engineering innovation. Introduced in the 1970s, they offer lower cost, reliable performance, and historically higher than average performance relative to active management with similar benchmarks. Often implemented within a core-satellite framework, index funds are a major component of today's investment industry.

Program or index trading arose in the 1980s to arbitrage price discrepancies between an index portfolio and its associated future. Superdot technology enabled efficient and convenient index trading. Index arbitrage results in very efficient market pricing of many indices.

Index ETFs can be characterized as Superdot enabled index fund program trading accessible to individual investors via stock exchange listing. ETFs are a two hundred plus billion dollar industry that is growing very quickly. Important reasons for growth include enhanced tax efficiency and generally lower expense ratios relative to traditional index fund investment. ETFs are an important institutional-quality tool for financial advisors for

facilitating a number of investment strategies.

Two of the three ETF presentations focus on expanding the ETF framework for active management. Active ETFs pose many interesting financial engineering and regulatory issues. While still under development, active ETFs may allow intra-day trading and stock exchange listing for institutional investment strategies. Benefits may include the development of new investment strategies and democratization of institutional asset management.

6. Actively Managed Exchange Traded Funds: Risk Modeling As An Enabling Technology

Charles (Tony) Baker, Managing Director, ETF Marketplace, American Stock Exchange, had made available a brief paper entitled "Actively Managed Exchange Traded Funds: Risk Modeling As An Enabling Technology."

He began with the simple structure of a mutual fund, its primary creation through cash investment for new shares, and the continuing purchase of new shares for cash and redemption of shares for cash. He moved next to the structure of a mutual fund as en exchange traded fund (ETF). The AMEX Specialist becomes the intermediary between the mutual fund and the investors. Investors buy ETF shares from, and sell them to, the specialist. Only the specialist transacts directly with the mutual fund. A specialist purchases new ETF shares from the mutual fund in exchange for a stock basket and redeems ETF shares by receipt of a stock basket. The process works satisfactorily at present for index mutual funds. The holdings of the mutual fund are known to everyone, because the composition of the index is known.

When we turn to actively managed ETFs we encounter two problems. First, the manager of the actively managed fund does not want to disclose the fund holdings. And second, it is necessary to reveal the net asset value so buyers and sellers of the shares know what they are buying and selling, during the trading day. Both the SEC and the marketplace require publication of at least an estimated net asset value every 15 seconds Further, the specialist with which the mutual fund trades its shares must be able to hedge its inventory. Baker described the American Stock Exchange plan for dealing with these problems.

First, the manager proposes a fund selection universe. This is the array of stocks from which the actively managed fund may select its holdings. The universe is likely to be fairly large, for protection of the secrecy of actual holdings. Second, the actual fund holdings at the end of a day are run through a principal components analysis, to determine exposure to multiple factors. The quality of the modeling process is key to the entire operation. Baker described the factors as not pre-specified. They are in fact determined by the data. By definition, the factors are common to all securities, and transient factors are captured. The next step is to draw from the established universe the IIV (intra-day indicative value) portfolio. The objective is an IIP that matches as closely as possible the actual fund portfolio in performance over the entire day. Each day the IIP is updated, using the modeling inputs from the actual portfolio the night before. During the trading day the value of the IIP can be published every 15 minutes, as a close approximation to the true value of the active portfolio.

The IIP serves a further purpose. It is the IIP that the specialist can use to hedge its inventory and to transfer to the actual portfolio for cash or receive from the actual portfolio for cash. The end result is that the specialist does not know the composition of the actual portfolio, nor do the investors on a day-by-day basis. But they are able to know within a close tolerance the net asset value of the actual portfolio and the specialist is able to deal with the fund and hedge its inventory to its satisfaction.

Baker described a number of tests that had been run to see how closely the

IIP matched the performance of actual actively managed portfolios.

He began using the S&P 500 index fund as an example of the actual portfolio and measured the differences between the value of the IIV and the value of the actual portfolio at ten-minute intervals for periods of several months up to a year. The differences were measured in terms of an average, a standard deviation, maximum, minimum, and the skewness of the distributions of differences. For the year 2001, and the S&P 500 Index, the average difference was 0.016%, with a standard deviation of 0.200%. Moving to an actual actively managed portfolio the management of which was willing to submit to the test, he found for the first half of 2001 an average difference of 0.023% and a standard deviation of 0.241%. For a second actual actively managed portfolio for several months in 2004, he found an average difference of 0.010% and standard deviation of 0.085%. What seemed particularly important from these measurements was that specialists appear to be satisfied that these differences were tolerable.

He went on to discuss the hedging processing in more detail, and displayed a graph showing at one-minute intervals, on a single day in 2002, the price of the actual portfolio, the price of the IIV portfolio, and the price of the hedge portfolio. The average difference between the actual and the IIV portfolio was 0.011%, and between the actual and the hedge portfolio was 0.054%. This seemed to be satisfactory to specialists. Baker's conclusion was that the Exchange has a modeling solution that successfully addresses the needs of the fund manager, the specialist, and investors.

7. The Nuts and Bolts of ETFs

George U. Sauter, Chief Investment Officer and Managing Director, The Vanguard Group, reviewed quickly the structure for ETF index mutual funds, and noted the exemptive relief needed to create an ETF. Under SEC regulations, mutual fund securities must be redeemable, and of course this is not true for an ETF, except with respect to the specialist. Second, every investment company security transaction must receive the NAV next determined. Third, there is a prospectus delivery requirement for every secondary market trade. And fourth, investors who own more than 5% of a registered investment company are "affiliates" and may not invest or redeem in-kind. Justification for exemptive relief had been explained by Baker in the previous presentation, in terms of the procedure the American Exchange had developed.

Sauter observed that ETFs are not in themselves a new product. They are another way to distribute an old product and this is important to mutual funds that can expect to reach a much broader range of investors if they can be traded as ETFs. The problem, as Baker had pointed out in the previous presentation, is that index mutual funds are easily adapted to the ETF form but actively managed funds are not.

Sauter went through in some detail the mechanics of the process that had been described in general terms by Baker. He also went into the characteristics of indexed ETFs. Conventional index mutual funds generally offer low cost, broad diversification, and relative tax efficiency. ETFs add flexible trading without the wait for the 4 p.m. pricing time, with short-sale availability and with margin purchases as well. Whether ETFs are low cost index funds compared to the conventional funds is not so clear. Sauter pointed out that there are 106 ETFs with conventional

alternatives. Of these about 69% compete against lower cost retail or high net worth alternatives. An interesting issue concerns shareholder record keeping costs that are borne by the fund organization itself in the conventional case, but by the brokerage community in the case of ETFs. He raised the question will the brokerage community continue to eat the cost of shareholder record keeping, or will brokers charge asset based fees?

In closing he raised the question of whether we are looking at a sea change in the way funds are distributed.

8. Reinventing the Mutual Fund: An Essential Piece of Financial Engineering

Gary L. Gastineau, ETF Consultants, LLC, made available a paper entitled "Reinventing the Mutual Fund: An Essential Piece of Financial Engineering."

He began by noting the extraordinary success of ETFs in the United States, having grown to $226 billion in less that twelve years, while it took US mutual funds more than sixty-six years to grown to $8 trillion. He continued with a comparison of annual shareholder costs for actively managed funds operating in the traditional equity mutual fund manner, with those for "a new equity fund" that he envisions, having many of the characteristics of an ETF.

He assumed a basic expense ratio of 1% for each category of fund, and portfolio composition trading costs inside the fund of 1.5%. He attributed 1.4% to share trading liquidity costs. This is the cost of allowing investors to buy into the fund and to redeem their shares without any extra charge, shifting the entire cost to all of the shareholders. He attributed another 0.35% to leakage of investment information, partly because of trading practices, and another 0.35% to what he called the "fund supermarket." This he contrasted with the use of specialized share classes providing custom management fees and marketing fee arrangements to accommodate different types of shareholders with investment objectives that coincide with the objective pursued by the fund. Again, for the traditional equity mutual fund he estimated costs of up to 2% as a performance penalty from over-sized funds. Total annual costs he then estimated at up to 6.60% for the typical actively managed mutual fund and 2.50% for his "new equity fund."

He offered a number of suggestions for features of the "new funds," to a large extent building on the expectations for actively managed ETF funds. He proposed a cut-off time at 2:30 pm for investor purchases and redemptions of shares, to be brought about at the 4:00 pm closing price. This would give managers time to compare purchase with redemption volumes and arrange for an orderly handling of the net difference at reasonable prices. The free liquidity problem is dealt with by the use of ETFs, where investors deal with the specialist rather than with the fund itself.

He offered a number of ways in which information leakage might be reduced or stopped. Conversion of a single ETF share class into specialized share classes would bring all similar accounts into one pool, and disclosure would be fund disclosure, quarterly with a sixty-day lag.

He discussed at some length the failure of active management. Berk and Green, in a presentation to the Q-Group® meeting in the Fall of 2003 concluded that there are indeed managers with superior skills, but that

the managers deliver superior performance for only a limited time. The difficulty is that rational investors find those skilled managers and invest heavily so that the funds become overly large and the managers are unable to deliver the performance they achieved with a smaller fund. The problem is a conflict between incentives for the manager and for the investor. Something has to be done to limit the growth of a fund and at the same change the manager compensation so that it does not depend entirely on the fund size. He suggested specifically capping funds, raising fees on institutional share classes, and raising fees on ETF share classes.

Previous presentations had described the risk factor model the American Stock Exchange proposes to use to develop a comprehensive proxy portfolio that would closely track the behavior of the actual fund portfolio. Gastineau proposed a significantly different factor model application. The combination of posted creation and redemption baskets and proxy values for the fund produced by his factor model application would provide as much information on the actual portfolio as the portfolio manager feels she can appropriately release to the market, and no more. The package of information released would be reflected in the combination of the frequency of publication of precise proxy values, the parameters of the distribution from which increments and decrements for the precise proxy values are drawn, the composition of the creation and redemption baskets, the factor model output, and the absence of leakage through non-fund products. By managing these five elements, Gastineau believed, the portfolio manager controls the information revealed, protecting current shareholders while providing as much information as possible to minimize fund share trading spreads.

In concluding, he said: "As the discussion of opportunities for higher investment management fees in response to superior performance on a smaller pool of assets suggests, there is no reason why a structure that better utilizes the talents of skilled active managers cannot compensate these managers more generously at the same time that it provides better results for investors."

9. Managing the Risk of Variable Annuities: A Decomposition Methodology

Thomas S. Y. Ho, President, The Thomas Ho Company Ltd, had made available a paper by himself and Blessing Mudavanhu, Vice President Credit Risk Analytics, Merrill Lynch & Company, entitled "Managing the Risk of Variable Annuities: A Decomposition Methodology."

Ho observed that the market of variable annuities has grown tremendously in recent years and has become a significant part of our capital markets. These equity and interest rate structured products offer a broad range of guarantees, whose risks are typically borne by the insurers' balance sheets. The management of the risk of these guarantees is an urgent problem to address. In this paper the authors apply a decomposition methodology to identify the risks of the guarantees. They then discuss the hedging strategies in managing those risks within the context of an investment process. He identified a number of the guarantees (in effect, options) that are embedded in variable annuities.

Variable annuities are retirement products sold by insurance companies to individuals, for both qualified and non-qualified accounts. The insurance

companies manage the retirement contributions over a duration, the accumulation period, for a fee, in their separate accounts. This is a simple concept, but in practice variable annuities are complex structured equity and interest rate products. The complexity arises from the multitudes of options that insurers offer their policyholders, particularly in the form of guarantees embedded and not detachable in these products.

The option Ho had chosen to focus on is the guaranteed minimum income benefit (GMIB) that offers the policyholder the option of receiving the account value or an annuity at the end of the accumulation period. This option leads to a complex mix of equity and interest rate risks embedded in the guarantee. In providing these guarantees the insurance companies have to bear both the market risks and the insurance risks on their balance sheets. In their paper, the authors describe only the salient features of the guarantee that is relevant for their paper. They assume that the variable annuity is a single premium product. The premium is invested in an equity index.

The return of the index is given by a martingale process with an expected return of μ and an instantaneous volatility of σ over a one month period. Let *S(n)* be the index value at time *n*, where each time period is one month. Then $S(n+1) = S(n)\exp\left(\mu - 0.5\sigma^2 + \sigma Z\right)$ where *Z* is the standardized normal distribution.

The fee of the variable annuity is paid monthly, and is a constant proportion of the account value at the end of each month. At the end of the accumulation period *T*, the policyholder can elect to receive the account value or a zero coupon bond, with maturity *T**. The authors use a zero coupon bond instead of an annuity, equal payments over a period of time, for clarity of exposition. A zero coupon bond can capture the impact of interest rate risks on the variable annuity. The model seeks to capture the key features of the option embedded in the GMIB which is the equity put option with a stochastic strike price. The model assures that the GMIB and the variable annuity can be viewed as standard contingent claims on the market interest rate and equity risks. Specifically, we assume a perfect capital market and use a discrete time model, a binomial lattice model with monthly step size to value the variable annuity and the GMIB.

The authors use the two-factor Ho-Lee model (2004) to model the interest rate risk. The characteristics of the model Ho set out as:

- Arbitrage-free 2-factor interest rate model
- No negative interest rates in valuing annuity
- No explosive interest rates in modeling equity return
- Recombining lattice
- Decouples stock return and bond rates
- Specify the interest rate distribution consistent with the market prices

To determine the initial set of benchmark securities to construct the replicating portfolio of the GMIB we begin with investigating the imbedded options in the GMIB. Suppose that there is no interest rate risk. Then the insurer has sold an equity put option to the policyholder with the expiration date at the end of the accumulation period. The strike price is the present value of the annuity on the expiration

date.

Suppose that the underlying equity has no risk. Then the equity index becomes a cash account and the premium is invested in cash. In this case, the GMIB is similar to a bond call option. At the end of the accumulation period, the policyholder has an option to exchange the "annuity" for the account value. When interest rates remain low, the annuity value would be high at the end of the accumulation period and the account value would be low. The policyholder would elect to take the annuity at a cost to the insurer. To replicate the embedded equity options, the authors use a series of equity put options on the equity index of different strike prices with the same expiration date, the end of the accumulation period. To replicate the interest rate risk, the authors use the bond call options with different strike prices but with the same expiration date.

To search for the optimal hedging portfolio, a step-wise regression is used. This iterative process allows us to identify the hedging instruments that can reduce the R squared significantly. Ho displayed the simulation results of the decomposition of the GMIB and the variable annuity. The result of the decomposition is a series of hedging instruments, including cash, equity puts, and bond calls.

10. Understanding Comovement

Nicholas Barberis, Professor of Finance, Yale School of Management made available a paper by himself, Andrei Shleifer and Jeffrey Wurglar, entitled "Comovement." He began by observing that there are numerous patterns of comovement of stock prices in the data available. Common factors in the returns of certain groups of assets seem to affect stocks within the same industry, small stocks, value stocks and closed-end funds. His question was what is the source of this comovement, and why do certain assets commove while others do not?

The traditional view is that comovement is essentially based on fundamentals. Assets comove because their "fundamental values" comove. Another way of expressing this traditional view is that the fundamental value of a stock depends upon a rational forecast of future cash flows discounted at a rate appropriate for risk. Comovement then is caused by correlated news about cash flows or correlated changes in discount rates which in turn depend upon changes in interest rates, changes in risk aversion, and correlated changes in rational perception of risk.

There is evidence however, on comovement not based upon fundamentals. An example can be found in the two companies Royal Dutch, traded primarily in New York, with a claim to sixty percent of the cash flow of the Royal Dutch and Shell combination, and Shell, traded primarily in London with a claim to the remaining forty percent. Under the traditional view of comovement, we would expect them to move in lock step. In fact, Royal Dutch comoves more with the US stock market and Shell more with the UK market.

Another example can be found in closed-end country funds. While the funds are traded in one location, fund assets can be found in another. The fund returns comove as much with the market where the fund is traded as with the market where the assets are traded.

Barberis presented evidence on more examples that appear to challenge the traditional view of comovement. He

suggested some reasons why many investors favor asset categories for investment. If categories are adopted by noise traders (irrational investors) with correlated sentiment, and if the noise traders affect prices, then assets will comove simply because they are classified in the same category. Barberis proposed an example. We imagine a world in which there are *2n* risky assets, with some investors grouping assets *1* through *n* in category *X* and other investors grouping assets *n+1* through *2n* in category *Y*. The categories are based essentially on sentiment, not on fundamental differences. Assume a shock f_M is a market induced shock that affects all of the assets, and that f_X and f_Y are shocks to the category *X* assets and to the category *Y* assets, respectively.

The consequence is:

For an asset *i* in *X*:

$$\varepsilon_{i,t} = \psi_M f_{M,t} + \psi_S f_{X,t} + \sqrt{\left(1 - \psi_M^2 - \psi_S^2\right)} f_{i,t}$$

For an asset *j* in *Y*:

$$\varepsilon_{j,t} = \psi_M f_{M,t} + \psi_S f_{Y,t} + \sqrt{\left(1 - \psi_M^2 - \psi_S^2\right)} f_{j,t}$$

where the *f* shocks are all i.i.d. over time, orthogonal to one another. The asset returns are given by:

$$\Delta P_{i,t+1} = \varepsilon_{i,t+1} + \frac{\Delta\mu_{X,t+1}}{\emptyset_1} + \frac{\Delta\mu_{Y,t+1}}{\emptyset_2}, i \in X$$

$$\Delta P_{j,t+1} = \varepsilon_{j,t+1} + \frac{\Delta\mu_{X,t+1}}{\emptyset_2} + \frac{\Delta\mu_{Y,t+1}}{\emptyset_1}, j \in Y$$

so long as arbitrage is limited in some way, two assets in the same category comove not only because of correlated cash-flows news, but because of a correlated sentiment shock.

Barberis turned next to some predictions that are testable. Suppose that risky asset, *j*, previously a member of *Y*, is reclassified as belonging to *X*. Then assuming a fixed cash-flow covariance matrix $\sum_D$, the estimate of $\beta_{j,X}$ in the regression

$$\Delta P_{j,t} = \alpha_j + \beta_{j,X}\Delta P_{X,t} + \beta_{j,Y}\Delta P_{Y,t} + \upsilon_{j,t}$$

rises after reclassification, while the estimate of $\beta_{j,Y}$ falls.

Barberis reported a testing of the prediction based on entry into and exit from the S&P 500 index of individual stocks. To perform the test we calculate the average change in the beta with respect to the index, before entry and after exit, and the average change in the R squared. We also calculate the average change in beta with respect to the non-S&P 500 stock market following entry and following exit. Regressions are run daily, weekly and monthly. The form of the bivariate regression is then:

$$R_{j,t} = \alpha_j + \beta_{j,SP500} R_{SP500,t}$$
$$+ \beta_{j,nonSP500} R_{nonSP500,t} + \upsilon_{j,t}$$

A table reporting the changes in beta showed that S&P 500 inclusion is associated with a substantial and significant increase in beta with the S&P and a substantial and significant decrease in beta with the rest of the market. Barberis pointed out as well that the shifts in betas are economically as well as statistically significant. He turned to the possibility that there are alternative explanations for the beta coefficient results. One cause might be inclusion in the index of stocks increasingly demonstrating a particular characteristic associated with a cash flow factor. Another possible source is that a particular industry is making up more of the value of the index and that new inclusions are likely to come from that industry. Testing to explore both of these alternatives involved finding matching stocks for each event stock, matching on market cap at the time of inclusion and growth in market cap over the previous twelve months. These

matching non-index stocks would come from the same industry as the stocks already examined. It was clear that the matching stocks did not show the behavior of the stocks entering and leaving the index.

A final alternative explanation might be increases in daily betas on entering the index because the typical included stock will trade more frequently after inclusion. Checking on this simply meant seeing whether the results held for the subsample of stocks whose turnover actually decreased after inclusion. The effects were strong in the subsample, confirming the expected behavior.

11. Stock Market Diversity

E. Robert Fernholz, Chief Investment Officer, INTECH had made available a paper entitled "Stock Market Diversity." Stock market diversity, first considered in Fernholz (1999), is a measure of the distribution of capital in an equity market. Diversity is higher when capital is more evenly distributed among the stocks in the market. Market diversity, as measured by any of the measures of diversity, appears to be mean-reverting over the long term with intermediate-term trends.

Certain measures of diversity generate portfolios, generically called diversity-weighted portfolios, and these portfolios have a more even distribution of capital than the market. The relative return of a diversity-weighted portfolio is perfectly correlated with the change in market diversity as determined by the measure that generates it. Certain diversity-weighted portfolios can be shown to have a higher return than the market portfolio, with about the same level of risk, at least over the long term.

It appears that active equity managers as a group hold portfolios with a distribution of capital that is closer to a diversity-weighted portfolio than to the market. This may enhance the manager's returns over the long term, but it also causes short-term relative returns to be correlated to changes in market diversity.

Fernholtz began with the classical representation of rate of return on a stock. Suppose that $X(t)$ represents the price of a stock at time t. If we assume that stocks pay no dividends, etc., then the return on this stock over time interval dt is $\frac{dX(t)}{x(t)} = \alpha(t)dt + \sigma(t)dW(t)$, where $\alpha(t)$ represents the *rate of return*, $\sigma^2(t)$ represents the *variance (rate)*, and W is *Brownian motion*, the continuous-time version of a random walk.

It turns out that it is advantageous to use the *logarithmic return (log-return)*, sometimes called the *continuous return*, rather than the classical return. In this case $d\log X(t) = \gamma(t)dt + \sigma(t)dW(t)$, where $\gamma(t)$ is the *growth rate* of X at time t. The growth rate is also sometimes called the *geometric rate of return*. The *logarithmic rate of return*, or the *continuous rate of return*. The relation between the rate of return and the growth rate is $\alpha(t) = \gamma(t) + \frac{1}{2}\sigma^2(t)$.

We go now to the measure of market diversity $D_p(\mu(t)) = \left(\sum_{i=1}^{n} \mu_i^p(t)\right)^{1/p}$, where $0 < p < 1$. We see that $1 \le D_p(\mu(t)) \le n^{(1-p)/p}$. Since early in the last century, US stock market diversity, measured by D_p has been *mean-reverting* with intermediate-term trends.

It can be shown that the measure of diversity D_p generates the *diversity-weighted* portfolio π with weights

$$\pi_i(t) = \frac{\mu_i^p(t)}{\sum_{j=1}^{n} \mu_j^p(t)},$$

and relative log-return

$$d\log\big(Z_\pi(t)/Z_\mu(t)\big)$$
$$= d\log D_p\big(\mu(t)\big) + (1-p)\gamma_\pi^*(t)dt.$$

- Compared to the market portfolio, π underweights the larger stocks and overweights the smaller stocks.

- The diversity-weighted portfolio is likely to outperform the market, because diversity is mean-reverting and the drift process is increasing.

For an all-long portfolio with more than one stock, $\gamma_\pi^*(t) > 0$, and measures the amount by which the portfolio growth rate *exceeds* the weighted average of the stock growth rates.

From all of the foregoing the conclusions are these:

- Lowering the concentration of capital in the largest stocks allows the diversity-weighted portfolio to outperform the market, without increasing the intermediate-term risk

- Active managers may take advantage of this phenomenon, perhaps unintentionally.

- If so, the average holdings of active managers would be closer to diversity weighting than to cap weighting.

- In that case, active managers' relative returns would be positively correlated with changes in market diversity.

- If trends in market diversity can be predicted, this could be helpful in the allocation of assets between active and passive managers.